



Bridging the Gap to 64-bit Computing

Rich Heye
Vice President
Computational Products Group, AMD

BRIDGE TO 64-BIT COMPUTING

APPLICATION -- SOFTWARE

OPERATING SYSTEMS

DEVICE DRIVERS

REFERENCE PLATFORMS

**HYPERTRANSPORT CONSORTIUM
DDR2 CONSORTIUM
32-BIT INFRASTRUCTURE
32-BIT BIOS LEVERAGE
ACPI 2.0 BIOS**

**HAMMER CPU
AMD-8151™ PCI-X BRIDGE
AMD-8131™ AGP BRIDGE
AMD-8111™ SOUTHBRIDGE
3RD PARTY CHIPSETS
0.13μ SOI PROCESS**

Why Bridge the Gap for 64-bit Computing?



Applications that can benefit:

- **Large memory applications**
 - Database, Digital Content Creation, MCAD & EDA
- **Security and Encryption**
- **Internet Content Delivery**
- **Simulation Examples**
 - Weather Prediction, Oil Exploration
- **Even 32-bit Applications benefit:**
 - 64-bit OS uses up less of applications' 32-bit address space.

What are the requirements?

- **Numerous discussions with OEMs, ISVs and end-users of workstations and servers identified only two**
 - 64-bit addressing capability
 - Excellent compatibility at high-performance

Two Different Approaches to Get Across the Bridge



- New Architecture: IA-64
- Unlike x86
- Intel's slowest processor for 32-bit applications
- New infrastructure and training required
- 2003 volume projected to be less than 23,000 processors

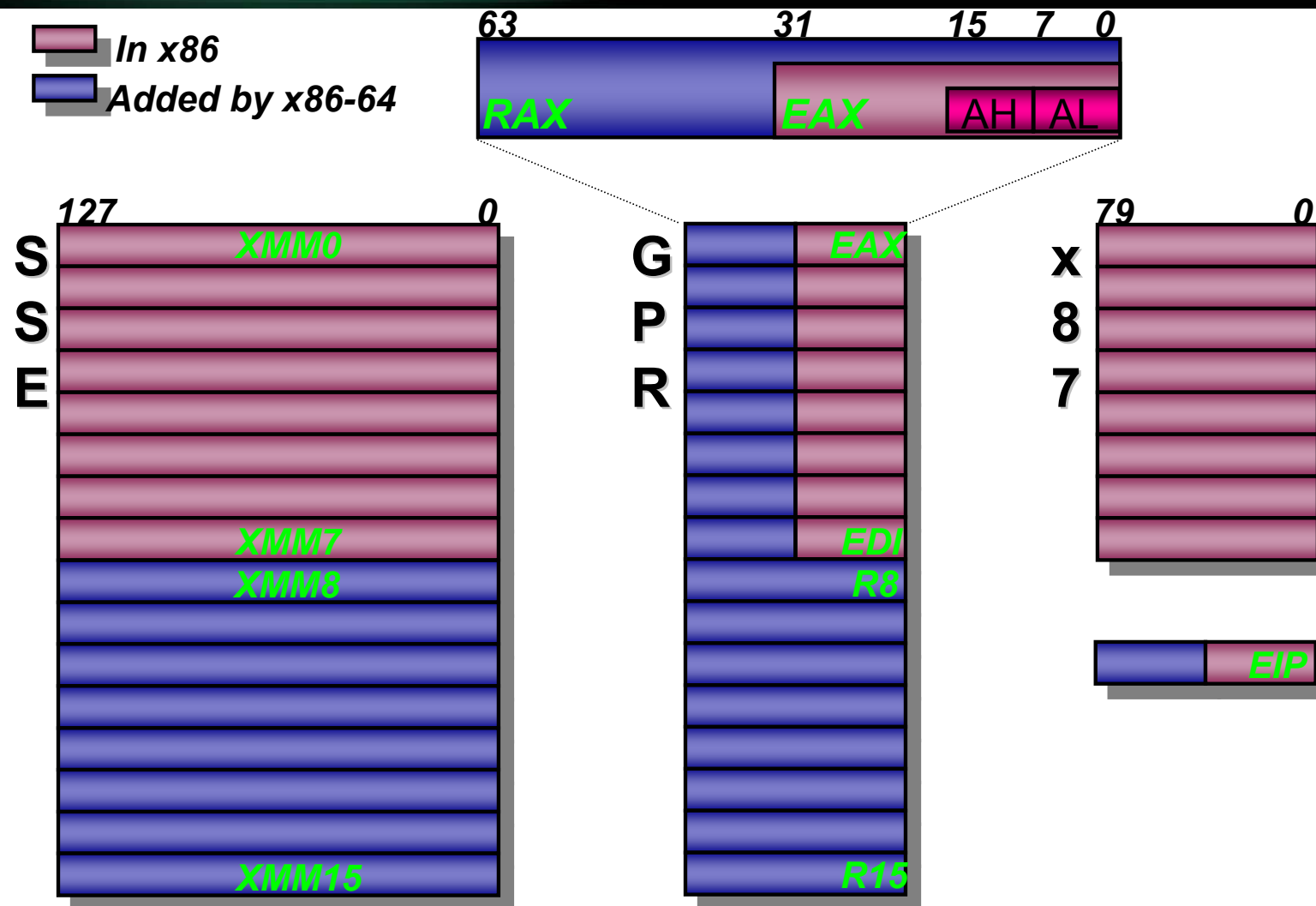


- Evolution of existing Architecture: x86-64
- Based on x86 instruction set
- AMD's fastest processor for 32-bit applications
- Leverages existing infrastructure
- 2003 volume for Hammer technology planned to be in millions
- 2004 volume for Hammer technology planned to be in tens of millions

Foundation: AMD's x86-64 Architecture

- With the two requirements in mind, AMD extended the x86 architecture to 64-bits and made the x86-64 architecture.
 - Processor running in 32-bit x86 Legacy mode executes today's 32-bit operating systems and application software.
 - Processor running in "Long mode" executes a 64-bit OS that can run 32-bit and 64-bit mode user applications.
 - 64-bit mode gives access to 64-bit addressing and 64-bit registers.
- Extensions are simple and compatible, so the processor can support both x86 and x86-64 at full speed & performance.
 - Customers get 32-bit performance & 32-bit compatibility
 - Customers can move to 64-bit addressing and data types w/o giving up 32-bit compatibility when needed.
 - Leverages the key PC infrastructure rather than needing to reinvent it.

x86-64 Programmer's Model



Foundation: Managing the Transition on the Infrastructure

- All Hammer processors include AMD x86-64 technology
- Transition to 64-bit computing will occur at the pace of demand for its benefits
- Transition from 286 to 386 is the perfect analogy
 - 386 was an initiative to create 32-bit capable processors
 - Initial users enjoyed highest performance 16-bit execution
 - Operating system and application development took time
 - Operating system support allowed 16-bit and 32-bit processes to coexist and interoperate
 - 32-bit software is now the norm
 - Although the 386 was introduced in 1985, 16-bit compatibility was important for years
- Great compatibility combined with great performance is the only practical approach to introducing new capabilities

Infrastructure & Industry Implications

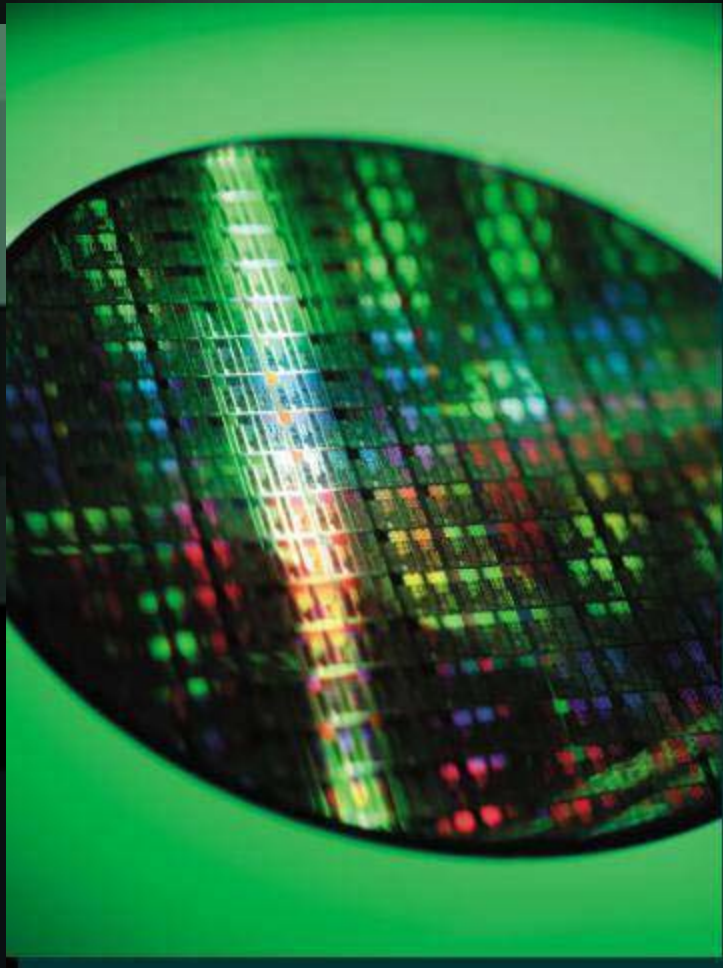
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|-------------------------------|--|
| Microprocessor vendors | <ul style="list-style-type: none">• Deliver 64-bit functionality with x86 compatibility• Bonus: 64-bit performance and 32-bit installed base |
| Platform suppliers | <ul style="list-style-type: none">• Designed to minimally impact motherboard design, OS, and stability• Decrease cost of technical support for two (32-bit and 64-bit) systems |
| Software vendors | <ul style="list-style-type: none">• Enable development of 32-bit and 64-bit applications in parallel without doubling costs• Not forced to choose between support for 32- or 64-bit application development |
| MIS managers | <ul style="list-style-type: none">• No need to plan for major IT transition, replace 32-bit apps, or retrain in-house development and support staff• No risk of being "left behind" with incompatible 32-bit technologies |
| End users | <ul style="list-style-type: none">• Not "forced" to upgrade to 64-bit apps and new OS• Leverage performance enhancements to dual 32/64 chips |

Only AMD x86-64 Technology Addresses All These Needs!

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AMD Silicon

Foundation: AMD Silicon & Hammer Family Processors

AMD Athlon™ processor (ClawHammer-DT)

- Performance Desktop Processor
- One 72-bit DDR channel supporting 200, 266, and 333 MHz
 - Future memory technology support as it is defined
- One 16-bit HyperTransport™ Link at 1600MT/s
- 256K-Byte and 1M-Byte integrated L2 cache products
- 754-pin mPGA Package

AMD Athlon (ClawHammer-DP)

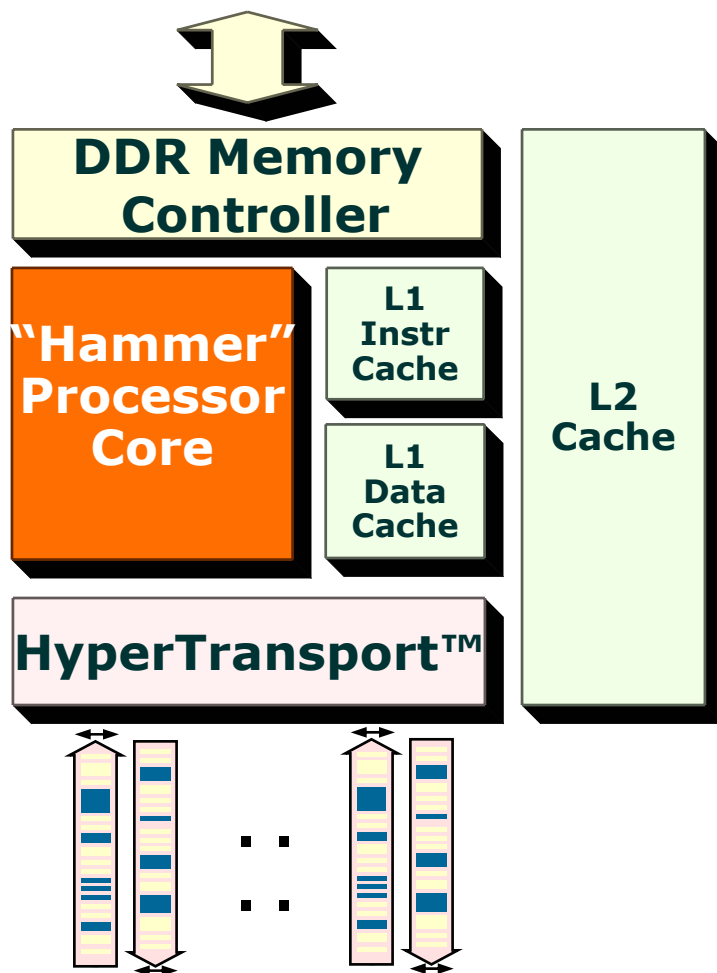
- 2-way Entry Server & WS Processor
- One 72-bit DDR channel supporting 200, 266, and 333 MHz
 - Future memory technology support as it is defined
- Two 8-bit HyperTransport Links at 1600MT/s
- 512K-Byte and 1M-Byte integrated L2 cache products
- 754-pin mPGA Package

**NOTE: All
Hammer family
processors
support x86-64
technology**

AMD Opteron™ processor(SledgeHammer-MP)

- Up to 8-way Server-Class Processor
- Two 72-bit DDR channels supporting 200, 266, 333 MHz
 - Future memory technology support as it is defined
- Three 16-bit HyperTransport™ Links at 1600MT/s
- 1M-Byte integrated L2 cache
- 940-pin mPGA Package

Hammer Processor & System Considerations



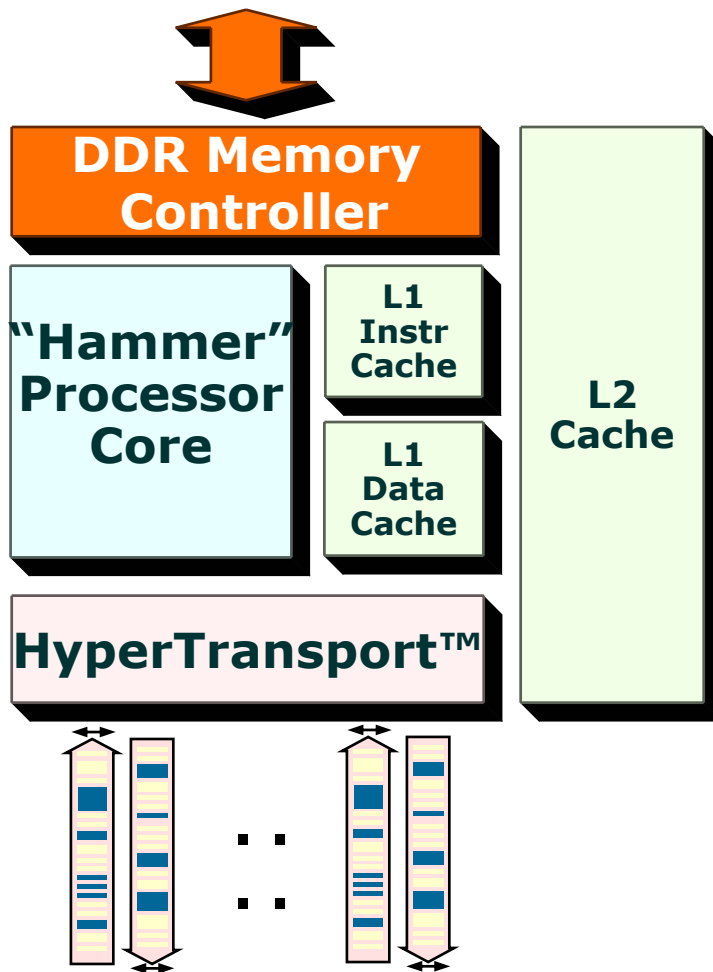
A successful Platform design requires a balance between:

- Processor performance
- Interprocessor communication performance in MP systems
- Memory performance
- I/O performance
- Scalability
- Cost and leveraging the existing infrastructure

If you don't get it all right, the processor can't help

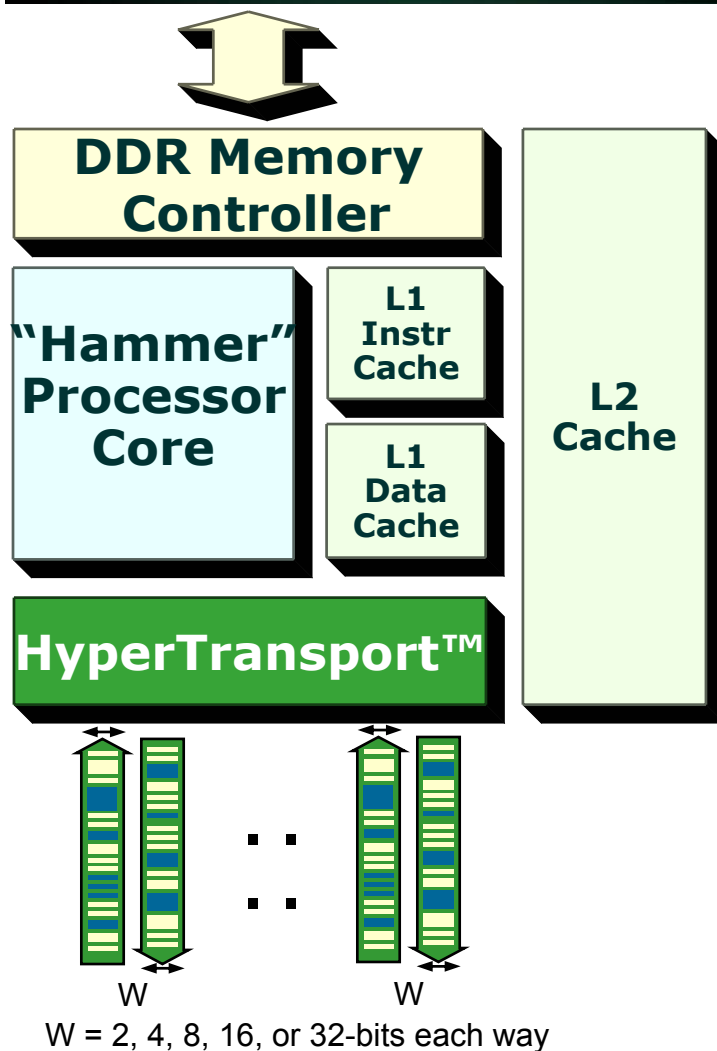
- Hammer processors & HyperTransport™ technology provide a platform solution based upon open standards that leverage the existing infrastructure
 - x86-64 ISA
 - DDR memory
 - HyperTransport connectivity

Hammer Memory Controller:



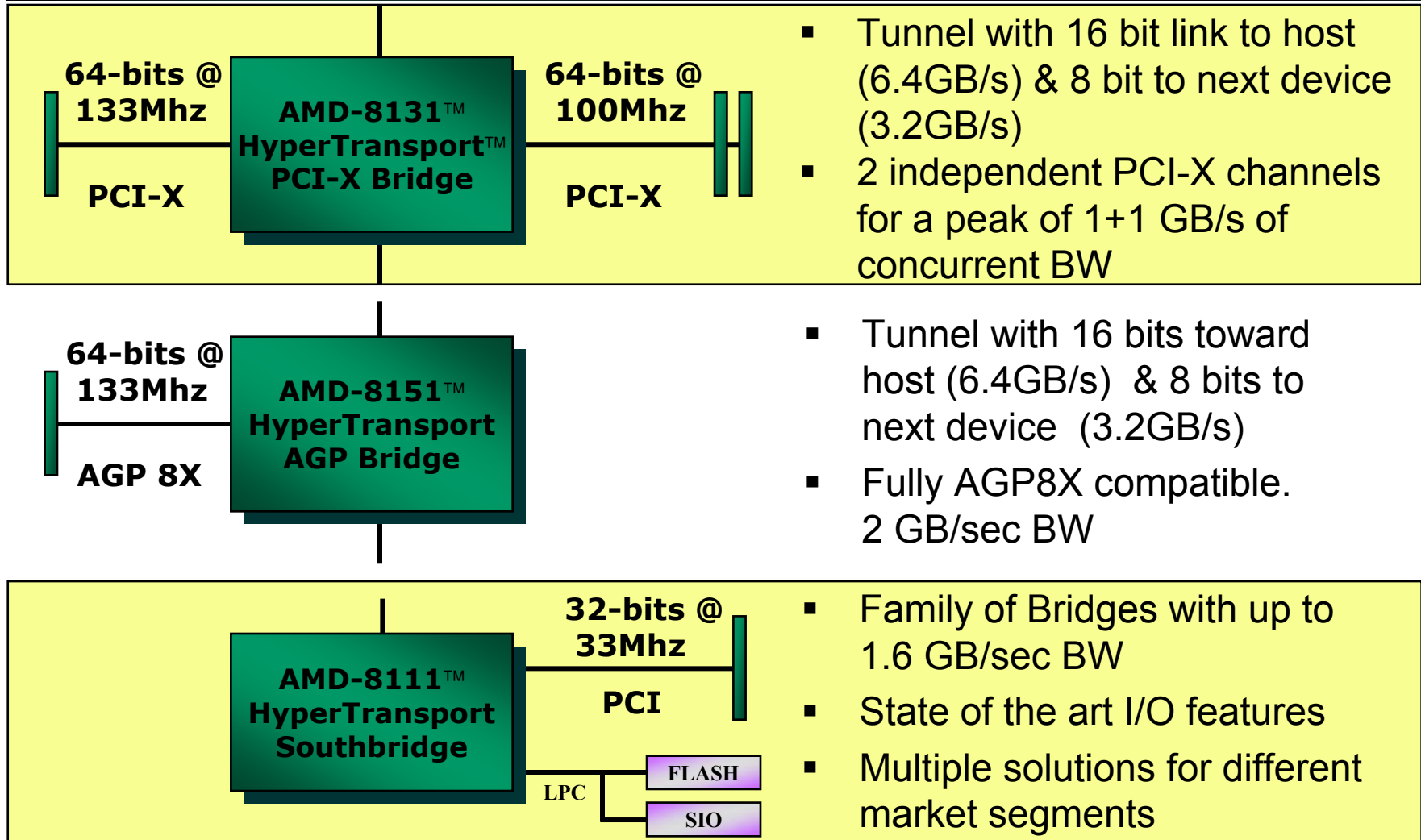
- Runs memory controller at processor speeds rather than FSB speeds
 - Today's AMD Athlon™ processor north bridge memory controllers run at 133 MHz
- Dramatically decreases latency
 - Quantispeed™ architecture achieves ~160 ns best case latency
 - Hammer architecture designed to achieve ~80 ns best case latency
 - Latency generally decreases further as the core frequency increases
- Add intelligence w/o decreasing performance
- Supports variety of DDR memories
 - 200, 266 and 333 MHz
 - Registered and unbuffered DIMMs
 - Future processor cores planned to support DDR-II, etc.

Hammer HyperTransport™ Interfaces



- **HyperTransport™ technology is**
 - High-speed, low pin-count, asynchronous, chip-to-chip board level interconnect
 - Proven technology in production today
- **HyperTransport is not**
 - A replacement for PCI and it's roadmap: PCI-X, PCI-X/DDR, PCI-3.0
 - A networking fabric
- **HyperTransport physical interface**
 - Point to point, differential, low-voltage swing
 - HyperTransport 1.0 -> Up to 1600MT/s to 12"
 - HyperTransport 2.0 -> Beyond 4000MT/s
- **HyperTransport logical interface**
 - 100% PCI compliant API
 - OS I/O (PCI) enumeration code untouched for Hammer processor based systems
- **High-profile, best-in-class partners**
 - Broadcom, Cisco, nVidia, SUN, & 100s more

Hammer HyperTransport™ Technology- Building Blocks



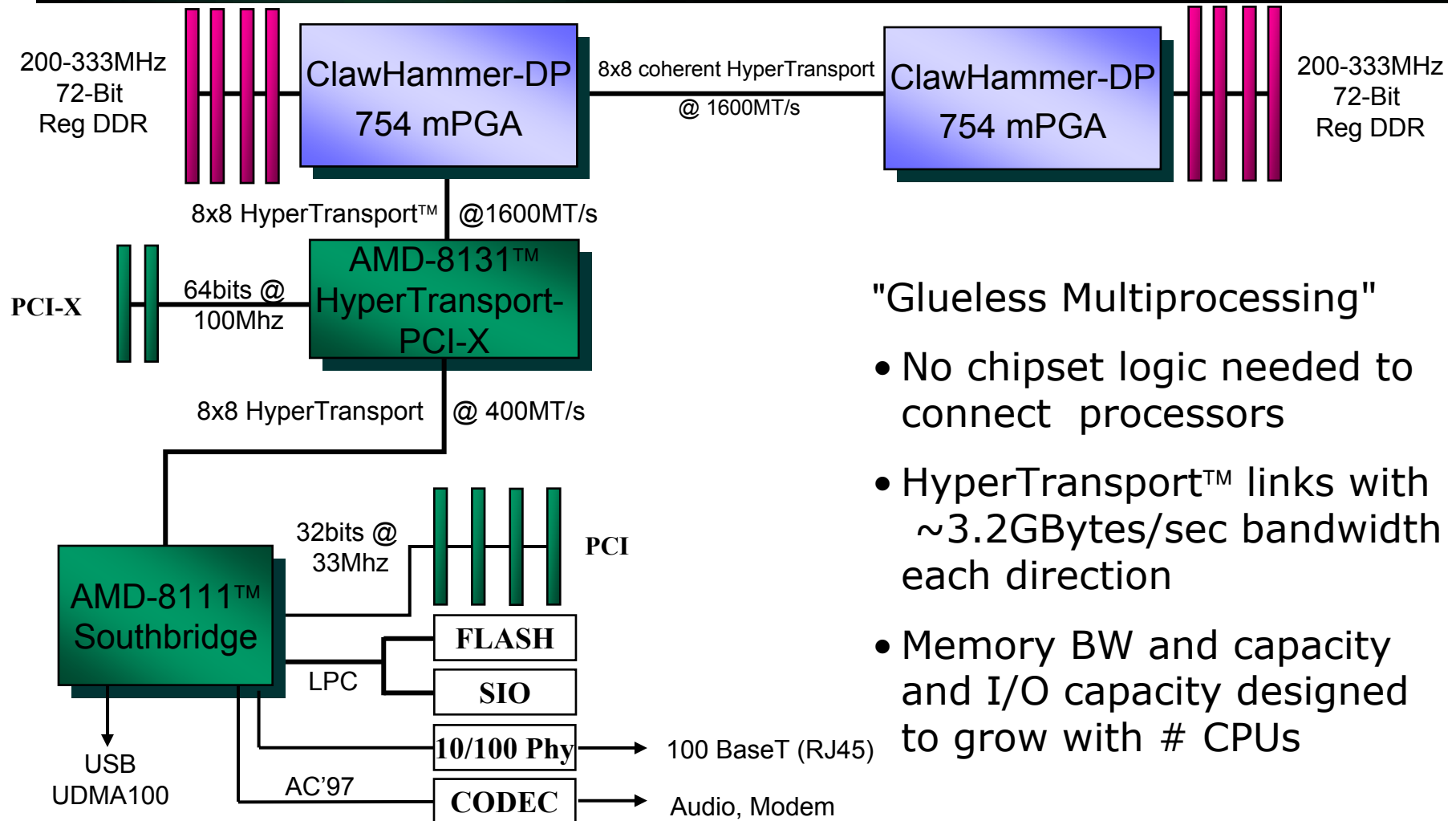
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Hammer Family Platforms

Platform Story

- Scalable systems must be built around efficient components
 - Power, cooling, board space and cost are crucial in building these.
- AMD provides the key building blocks for scalable Hammer platforms:
 - Glueless Multiprocessing through integrated memory controller and North Bridge on the Hammer processor die.
 - HyperTransport™ interconnect and Devices (PCI-X, AGP-8x, etc)
 - Reference platform designs provide concrete examples to our OEM partners.
 - Hammer thermal/mechanical solutions are designed to meet the demanding requirements of PC and 1U form factors
- An OEM, working with AMD, designs retail platforms customized to the OEM's needs and markets.

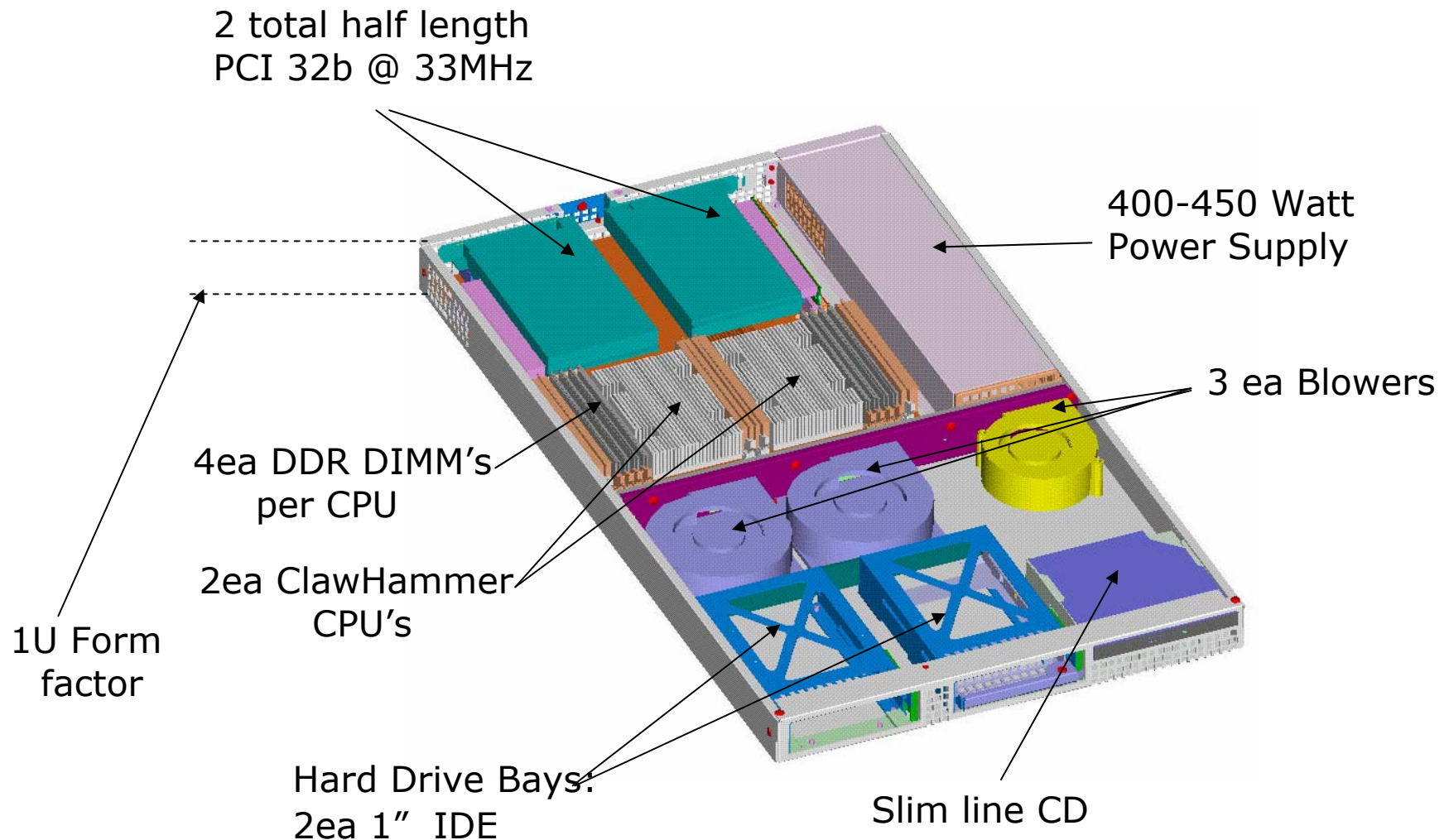
Hammer 2P System Builder Server (Stretto)



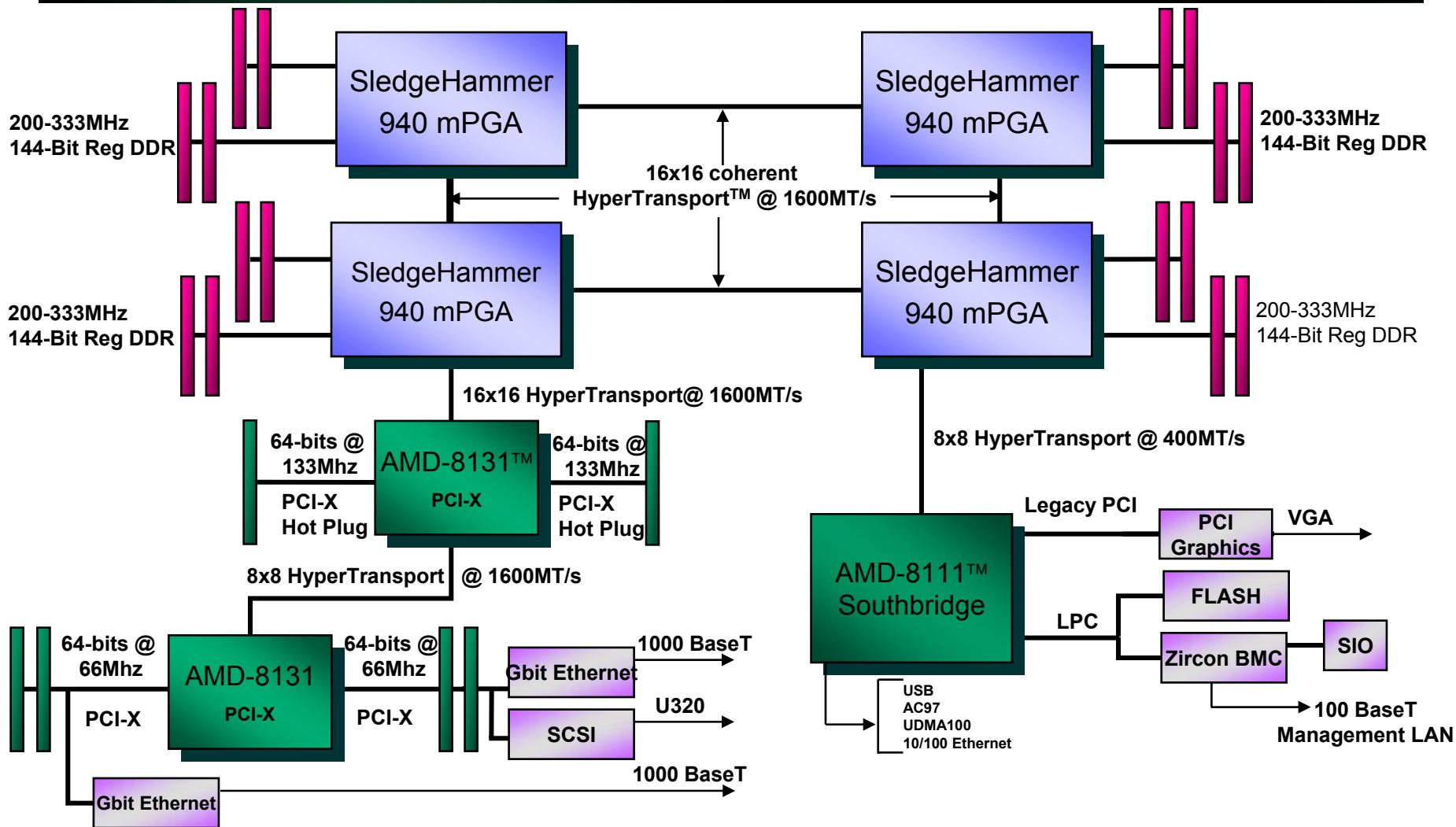
"Glueless Multiprocessing"

- No chipset logic needed to connect processors
- HyperTransport™ links with ~3.2GBytes/sec bandwidth each direction
- Memory BW and capacity and I/O capacity designed to grow with # CPUs

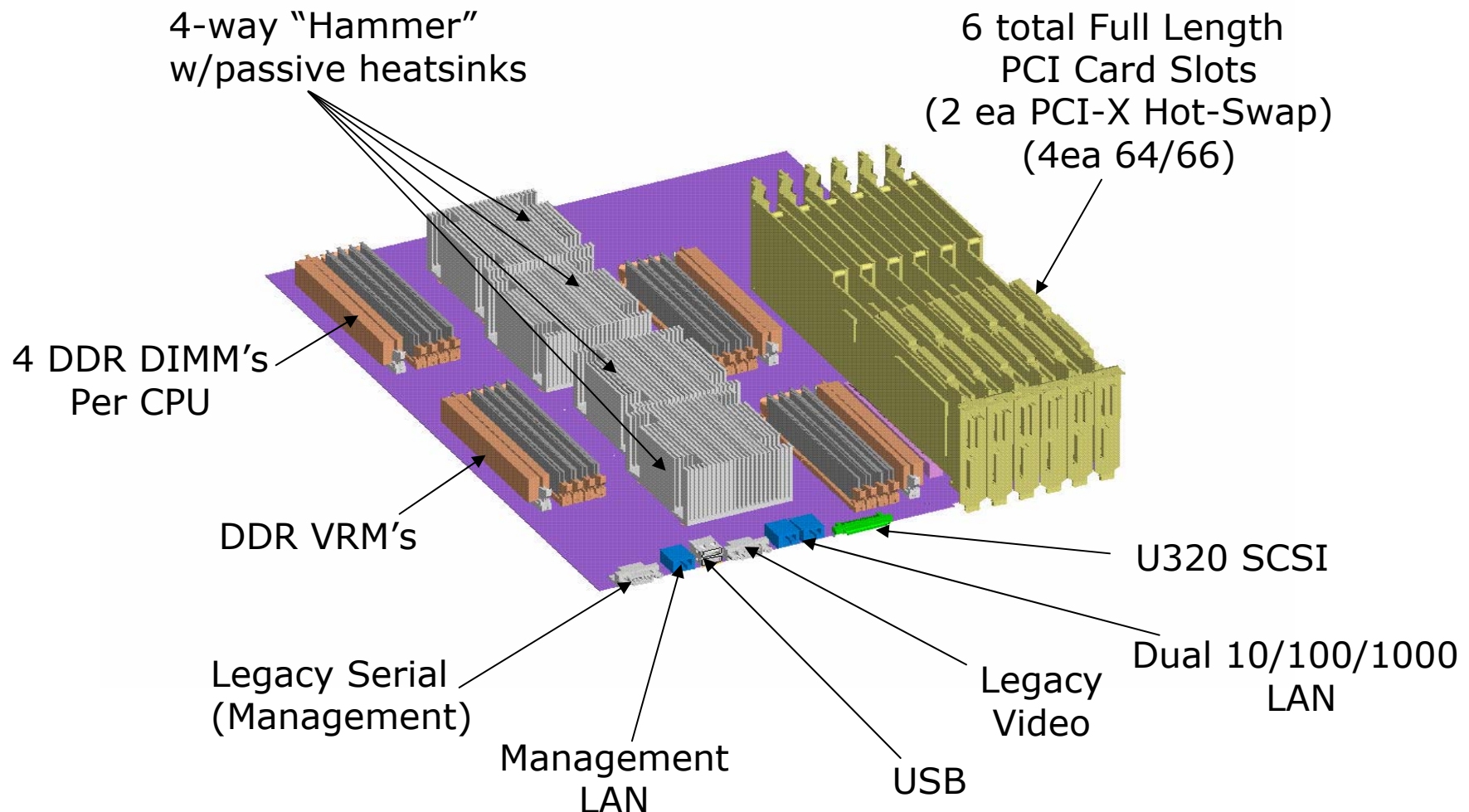
1U System Builder Box Example



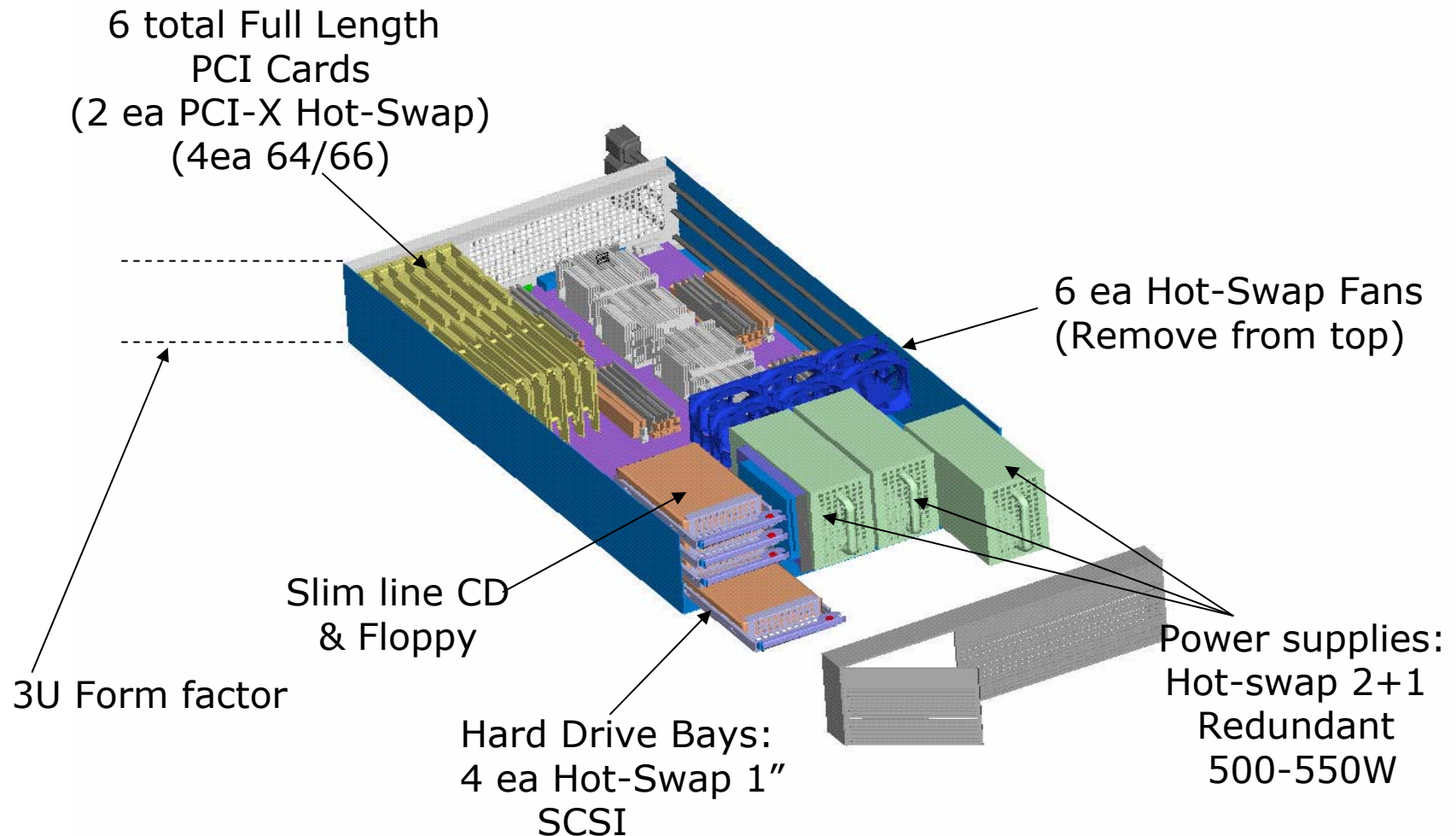
Hammer 4P Server (Quartet)



4P Board Layout



4P System Concept (Front-view)



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System Software Support

Firmware Considerations

- 32-bit BIOS is sufficient for 32- and 64-bit operating systems
 - BIOS implementation is evolutionary; one firmware image designed to support any OS
 - EFI capable BIOS is not necessary
- Enhance existing BIOS core to support Key Hammer changes:
 - HyperTransport™ technology
 - PCI enumeration & Routing tables initialization and maintenance
 - Integrated Northbridge
- AMD actively working with BIOS infrastructure
 - 3rd-party BIOS engineering on-site at AMD facilities
 - All 3rd-party BIOS partners have booted several operating systems on platforms based on Hammer processors
 - Prototypes and production release driven by AMD and customers



32-bit Software Running on 32-bit Operating System


- Designed to provide leading-edge x86 performance
 - Designed to provide >20% increase clock-for-clock compared to AMP Athlon™ processor
 - No tools or OS work suggested or recommended
- Hammer includes all SIMD instruction sets
 - 3DNow!™, Enhanced 3DNow!, 3DNow! PRO (SSE), SSE-2 technologies
 - Designed to support more software than any other x86 processor
- Designed for full ISA compatibility with 16- or 32-bit x86 OS
 - AMD validates over 50 OS releases including
 - Windows® (3.1, 9x, Me, 2000 Pro, 2000 Server, 2000 AdvancedServer, WfW, XP)
 - Windows NT® (3.51 WS, server, 4.0 w/SP6, NT 4 Workstations)
 - DOS (MSDOS 6.21, Novell DOS 7.0, PC DOS 6.1, 6.3, 7.0)
 - Linux (Mandrake 7.0, 7.1, Redhat 6.0, 6.1, 6.20, 7.0, Slackware 1.2, 2.0, SuSE 7.0)
 - Unix (SCO, FreeBSD 3.0, Solaris 2.5, 2.6, 7, 8)
 - Misc (OS/2 Warp3.0, 4.0, Be 4.5, 5.0, Netware 4.11, 4.2, 5.0, 5.1)
- Designed for full compatibility with millions of 16- and 32-bit applications, devices and drivers
 - Extensive compatibility testing at AMD and by 3rd-party labs

Linux x86-64 Development


- SuSE is lead contractor of x86-64 Linux port
 - Providing all kernel, development tools, and basic device driver patches
 - AMD has greatly benefited from SuSE's Kernel expertise.
- Accepted source changes go to appropriate repositories:
 - GCC 3.x
 - Development is to Kernel 2.4; changes are sync'd with 2.5.
 - Working in a very "open source" manner. See www.x86-64.org for details.
- SuSE & AMD have just released SuSE Linux for x86-64 Beta 1.0.
 - Complete native distribution with installer, 64-bit kernels, 64-bit XFree86, 64-bit KDE, 64-bit tools, 64-bit device support.
 - Excellent support of 32-bit Applications under the 64-bit Kernel
 - Available to companies platforms based on Hammer processors
- SuSE Professional and Enterprise releases for x86-64 planned to be in conjunction with Hammer System availability in 2003.



More x86-64 Operating System Development

-  **UNITED LINUX** (SuSE, SCO, Connectiva, Turbolinux)
 - Plans to provide support in conjunction with Hammer System availability in 2003.

- 
 - Plans to provide x86-64 support in next mainline releases of Red Hat Advanced Server and Red Hat Workstation.
 - Full support for 32-bit and 64-bit applications under a 64-bit OS.
 - Committed to supporting OEM and end user versions
 - Working together with Enterprise ISVs to enable x86-64 on Linux

-  **MandrakeSoft**
 - Plans to provide support in conjunction with Hammer System availability in 2003.
- NetBSD: has ported x86-64
- FreeBSD: working on port
- Other OS vendors are evaluating x86-64 technology

Microsoft x86-64 Support

- AMD & Microsoft are working together to continue growing 64-bit computing.
- Microsoft plans to support 8th-generation AMD Athlon™ and AMD Opteron™ processors by extending existing 64-bit support in Windows®.
- Microsoft plans to enable partner development for Windows on x86-64 using historical programs such as the Microsoft® Windows Technical Beta program.
- In June 2002, Microsoft released Microsoft Windows DDK for x86-64 Pre-Alpha. Microsoft has recently released an x86-64 Platform SDK.
- Microsoft plans to create evangelism programs to assist partners in their port to Windows for the x86-64 architecture.
- It is intended that developers can take advantage of Microsoft's cross-platform support using a single Windows API and by following 64-bit Windows programming guidelines.



Foundation: Leveraging the Infrastructure

Leveraging the Infrastructure for AMD's Open Platform

- AMD is aggressively pursuing industry-leading SW and HW developer support
 - Evangelism group exceeds 30 people, world-wide
 - Partner reaction is very positive

BIOS

AMI
Phoenix
Technologies

Chipset

ALi Corporation
ATI Technologies
NVIDIA
SiS Corp.
VIA

Technology

Voltage

Regulators

02Micro
Intersil
Linear
Technology
Semtech
Fairchild

Clock Generator

Cypress
Integrated Circuit
Systems
Texas Instruments

Graphics

Vendors

3DLabs
ATi
Matrox
NVIDIA
SiS

Phase Locked

Loop

Socket

Foxconn
Molex Inc.
TYCO

Motherboard

ABIT Computer
Corp.
Acorp
Albatron
Aopen
ASUSTeK
Computer Inc.
Chaintech
BIOSTAR
DFI
ECS
EpoX
FIC
Flexus
GIGABYTE
Technology
Iwill
TYAN

Motherboard

Jetway
Leadtek
Legend
Lucky Star
MSI
Shuttle
Soltek
SOYO

LPC Flash

SST
STMicro
Winbond
Memory
Samsung
Nanya
Hynix
Infineon
Micron

Development Tools & Application Support



The Portland Group Compiler Technology

STMicro/PGI plans to provide an optimized x86-64 Fortran77/90 compiler with OpenMP support for 64-bit versions of Linux and Windows



NAG plans to provide optimized math routine libraries for 64-bit versions of Linux and Windows



MigraTEC plans to provide their industry-leading 64Express source-code-migration technology for x86-64 on both Windows® and Linux



Etnus has announced 32-bit support of x86-64 with their TotalView distributed debugging product



Applications can take advantage of IBM's x86-64 Linux port of DB2



Status & Conclusion

AMD Hammer & Chipset Status

- Deploying Hammer Rev A2 silicon.
 - Now sampling Hammer B0. Looks good.
- Deploying Single, Dual & Quad processor development platforms
 - ~435 single processor systems in use worldwide
 - Last shipment has validated AGP8x support
 - ~130 2-4P systems in use worldwide
 - Last shipment has full PCI-X support
 - In the hands of 120+ companies
- 32-bit compatibility and performance on track
 - Hundreds of OS and applications tested

AMD Hammer & Chipset Status (cont)

- 64-bit development and performance on track
 - Windows® and Linux running and stable
 - System performance on track
 - No problems experienced with 32-bit compatibility
 - Performance tracking very well (~20% advantage to being 64-bit native)
- Infrastructure fully engaged
 - Uni & Dual processor RDKs in Taiwan
 - BIOS community on track
 - Chipset partners have first silicon

Conclusion: The Bridge to 64-bit Computing

- The Bridge to 64-bit computing requires firm foundations:
 - AMD has laid the right foundations by designing a high-performance x86-compatible processor that leverages the existing 32-bit PC infrastructure
- The Bridge requires sturdy arches to span between the foundations:
 - AMD has a compelling, “overarching” platform strategy that is augmented by key support from peripheral and system software vendors.
- The Bridge requires a smooth transition across:
 - Working with Tools vendors, Application vendors, and You, we can provide the software to make the transition to 64-bits enticing and smooth.
 - Preserving world-class 32-bit performance and compatibility ensures that our customers don’t get stuck at either end of the bridge.

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